

Orthodontic treatment of a patient with severe crowding and unilateral fracture of the mandibular condyle

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A 15-year-old girl who had a unilateral condylar fracture with severe crowding in both arches was treated with 4 premolar extractions followed by orthodontic therapy with a temporary skeletal anchorage device in the maxillary arch. The total active treatment time was 21 months. Her occlusion was significantly improved by orthodontic treatment, and the range of condylar movement was also improved. Posttreatment records after 30 months showed excellent results with a good stable occlusion. The remodeling process of the condyle was confirmed with cone-beam computed tomography images. (Am J Orthod Dentofacial Orthop 2016;149:899-911)

Whereas mandibular fracture has the second highest incidence rate among facial bone fractures, condyle fracture accounts for 29% to 52% of all mandibular fractures, making it the most frequent facial fracture.^{1,2} Nonsurgical treatment has been commonly accepted and recommended for pediatric patients; however, the treatment of choice for a condylar fracture in adults has remained controversial for many years.³ Currently, the classification system of Lindahl⁴ for condylar fractures is most generally accepted and used. According to it, condylar fractures can be divided anatomically into 3 sites: intracapsular (condylar head), extracapsular (condylar neck), and subcondylar region. Furthermore, Lindahl classified the extent of dislocation into medial, lateral, and no overlap or fissure, and condylar head fractures into horizontal, vertical, and compression.

Although a fractured mandibular condyle has shown regeneration similar to its original size in most cases,^{5,6} it can also be associated with deteriorating side effects including mandibular deficiency, temporomandibular joint (TMJ) dysfunction, or facial asymmetry, if not managed properly.⁷⁻⁹ Treatment of a condylar fracture depends on various factors including the extent of the injury, the level of the fracture, the size and position of the fractured condylar segment, the degree of dislocation and displacement, the stage of the dentition, the presence of a facial fracture, malocclusion and mandibular dysfunction, and the age and willingness of the patient to have surgery.^{3,10,11} The treatment options range from conservative treatment consisting of observation, analgesia, and a soft diet, to maxillomandibular fixation or functional appliance therapy,^{5,12} and in some cases surgical intervention.^{6,13-16} In growing patients, most authors have recommended the conservative approach because of the growth potential of the condyle.^{6,14,15} This article demonstrates the successful orthodontic treatment of a 15-year-old girl with a unilateral condylar fracture that was treated conservatively. Normal occlusion and jaw movement were achieved, and satisfactory condylar process remodeling and possible repositioning of the temporomandibular fossa through apposition were observed.

DIAGNOSIS AND ETIOLOGY

A 15-year-old girl was referred for an evaluation of orthodontic treatment. Her chief complaint was ectopically erupting maxillary canines. During her

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All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.

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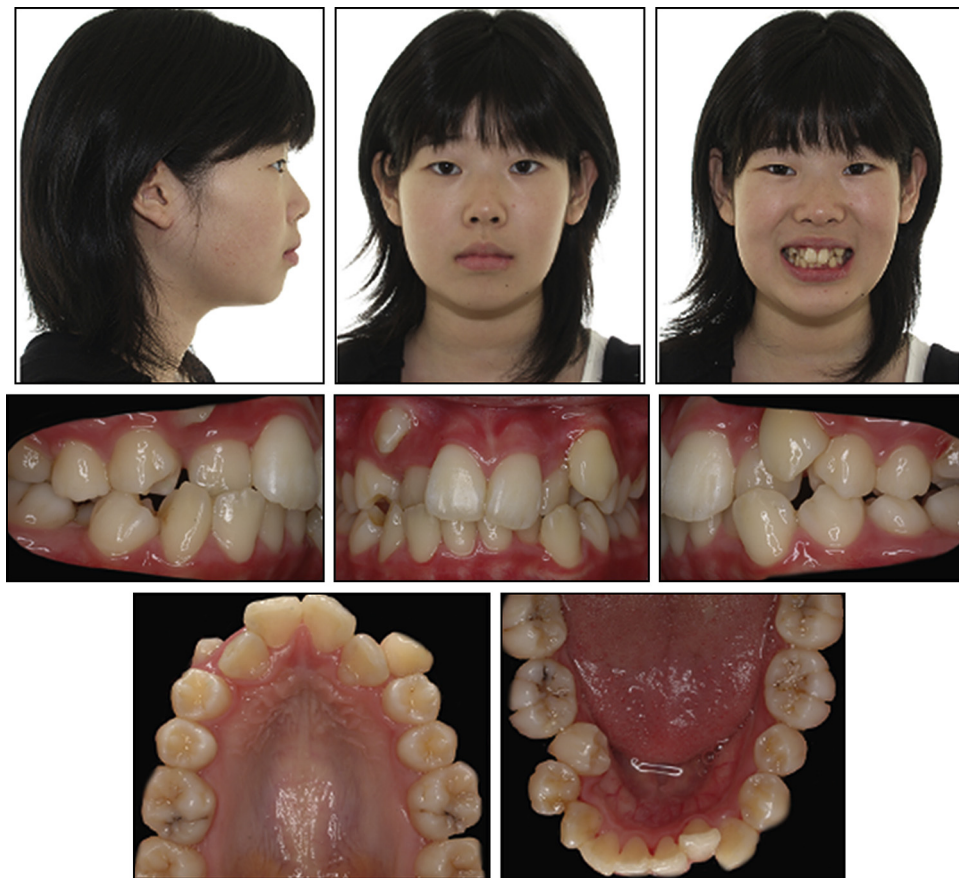


Fig 1. Pretreatment facial and intraoral photographs.

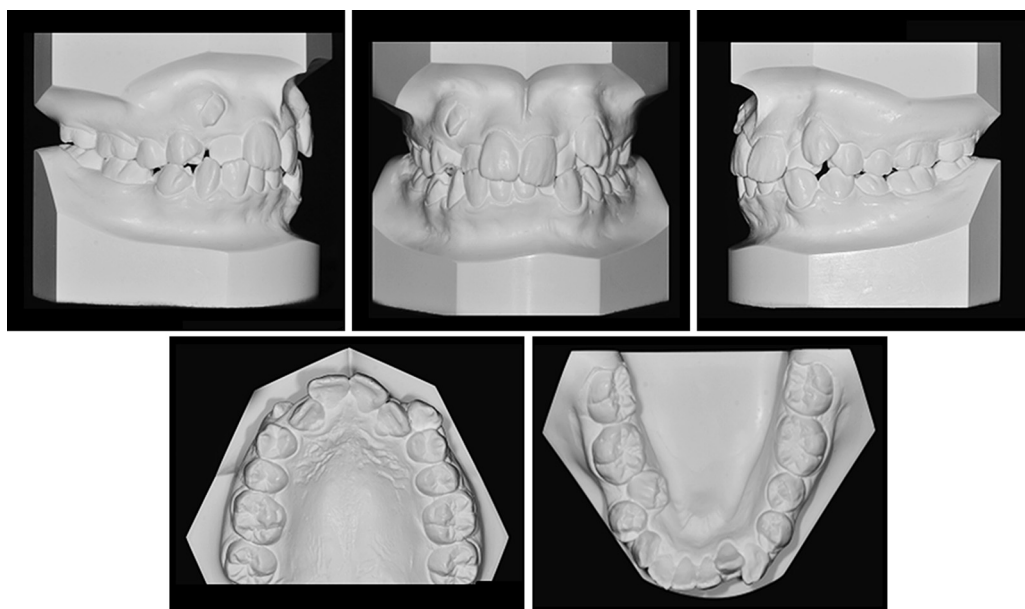


Fig 2. Pretreatment dental casts.

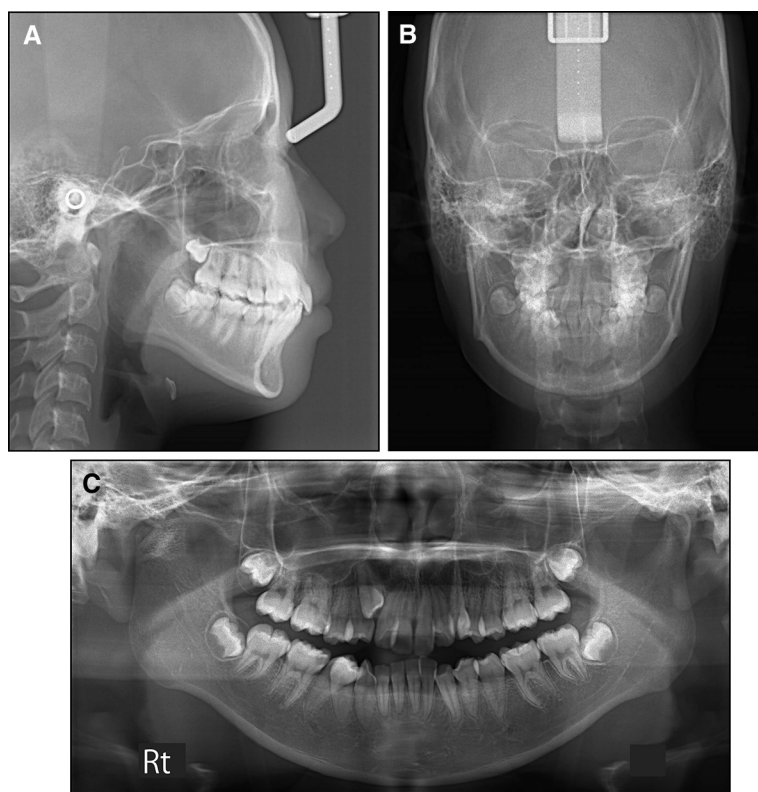


Fig 3. Pretreatment radiographs: **A**, lateral cephalogram; **B**, posteroanterior cephalogram; **C**, panoramic radiograph.

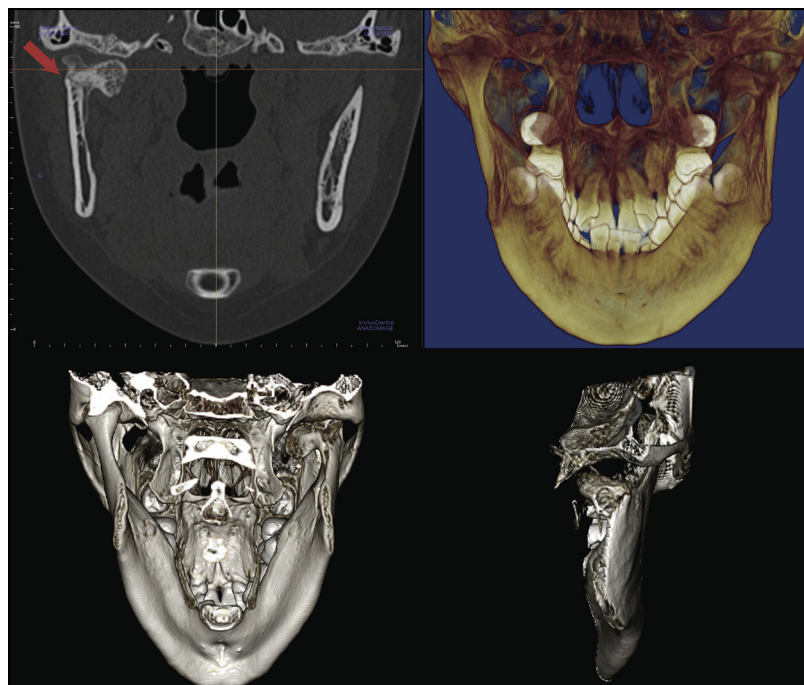
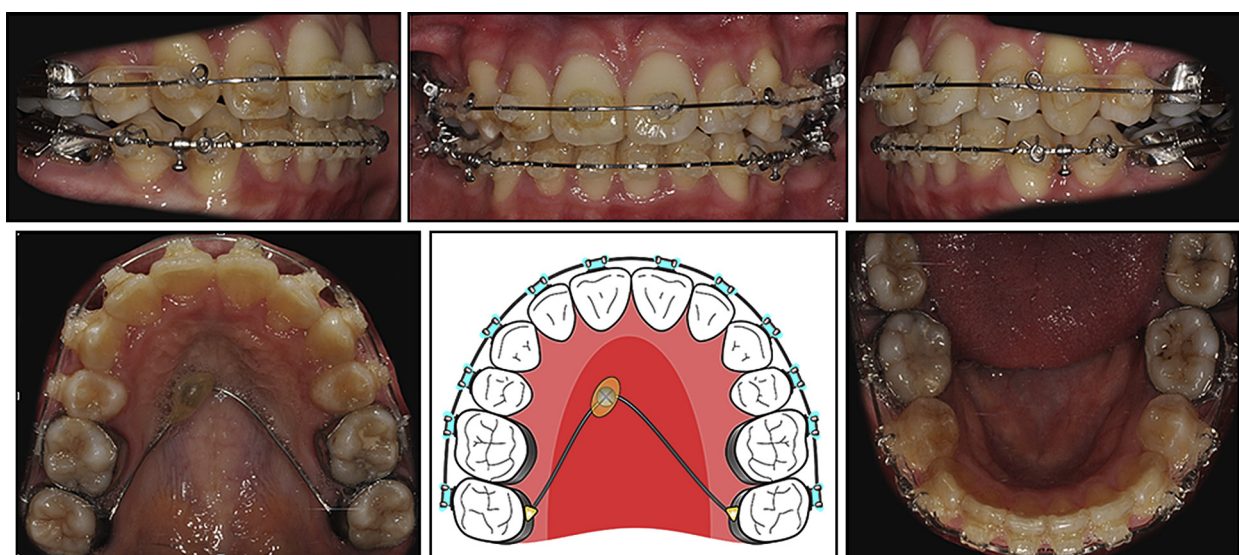


Fig 4. Initial CBCT scan showing the mandibular right condylar fracture with medial deviation.

Table. Cephalometric measurements

Measurement	Japanese norm	Pretreatment	Posttreatment	Postretention
SNA (°)	82.0	84.2	84.1	84.6
SNB (°)	79.9	79.9	80.6	81.3
ANB (°)	2.0	4.3	3.5	3.3
Wits (mm)	1.1	-3.9	-4.7	-4.3
SN-MP (°)	34.0	33.6	34.1	33.9
FH-MP (°)	28.2	26.0	26.8	26.6
LFH (ANS-Me/N-Me) (%)	55.0	59.0	58.5	58.6
U1-SN (°)	104.0	114.6	107.4	107.5
U1-NA (°)	22.0	30.3	23.3	22.9
IMPA (°)	90.0	102.1	93.4	93.5
L1-NB (°)	25.0	35.6	28.1	28.7
U1/L1 (°)	124.0	109.7	125.1	124.8
Upper lip (mm)	1.2	2.6	0.8	0.2
Lower lip (mm)	2.0	3.7	2.1	1.5

**Fig 5.** Progress intraoral photographs of the TSAD as indirect anchorage.

orthodontic evaluation, she reported that she had suffered a traffic accident 7 months ago and was in splint therapy. At the emergency hospital, she received immediate therapy consisting of antibiotics, anti-inflammatory analgesics, a soft diet, and physiotherapy (passive and active mouth opening).¹⁷⁻¹⁹ Clinically, upon opening her jaw, the mandible deviated slightly to the affected right side. She had no temporomandibular disorder symptoms such as pain, restricted jaw movement, joint noise, or other symptoms. During the TMJ evaluation, she did not report muscle or joint pain or other symptoms typically associated with a temporomandibular disorder.

The patient had a mesofacial and Class I appearance. There was no significant facial asymmetry.

Intraorally, she had anterior crossbites, a lingually displaced mandibular right second premolar, and a buccally positioned maxillary left canine, and the maxillary right canine was also erupting in an ectopic position. She had a 2-mm overjet and an 80% overbite on her maxillary left central incisor. Her maxillary left central incisor showed more extrusion than did her maxillary right central incisor, and there was canting. She had a Class I molar relationship on both sides. She showed severe crowding in both arches with a deep curve of Spee. Compared with her facial midline, the maxillary dental midline was shifted 1.5 mm to the right, and the mandibular dental midline was deviated 2.5 mm to the right (Figs 1 and 2).



Fig 6. Posttreatment facial and intraoral photographs.



Fig 7. Posttreatment dental casts.

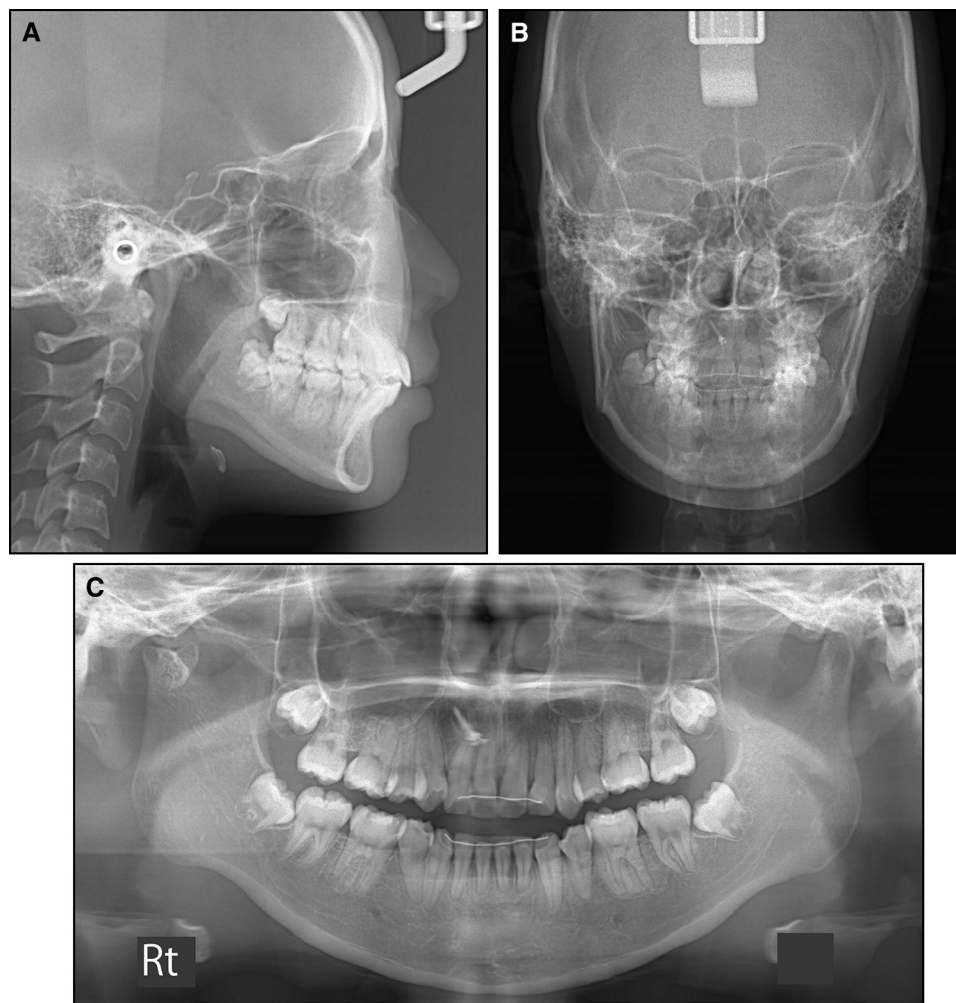


Fig 8. Posttreatment radiographs: **A**, lateral cephalogram; **B**, posteroanterior cephalogram; **C**, panoramic radiograph.

The panoramic radiograph showed an abnormally shaped right condylar head. All third molars were erupting. From a posteroanterior cephalogram and cone-beam computed tomography (CBCT) image, the right condyle was found to be fractured at the neck of the condyle and deviated medially with no other alterations of the facial bone structures.¹⁸ The lateral cephalometric analysis indicated a skeletal Class II pattern (ANB, 4.3°) with a normovergent growth pattern (SN-MP, 33.6°). The maxillary and mandibular incisors were proclined (U1 to SN, 114.6°; IMPA, 102.1°) (Figs 3 and 4; Table).

TREATMENT OBJECTIVES

The following treatment objectives were established: (1) observe the remodeling of right condyle, (2) relieve the crowding in both arches, (3) correct the anterior

crossbites, (4) improve the deviation upon opening and correct the dental midline, (5) establish Class I canine and maintain Class I molar relationships, (6) obtain normal overjet and overbite, (7) level the curve of Spee, (8) obtain a stable occlusal relationship, and (9) improve the facial and dental esthetics by establishing an esthetic smile.

TREATMENT ALTERNATIVES

Condylar fractures in childhood are generally treated conservatively without surgery.^{14,17-19} Many previous studies have recommended conservative therapy for condylar fractures in pediatric patients.^{5,15,18} “Conservative therapy” includes a nonsurgical approach with several modalities such as physiotherapy with observation.¹⁵ Open reduction is proposed in certain cases such as severely displaced

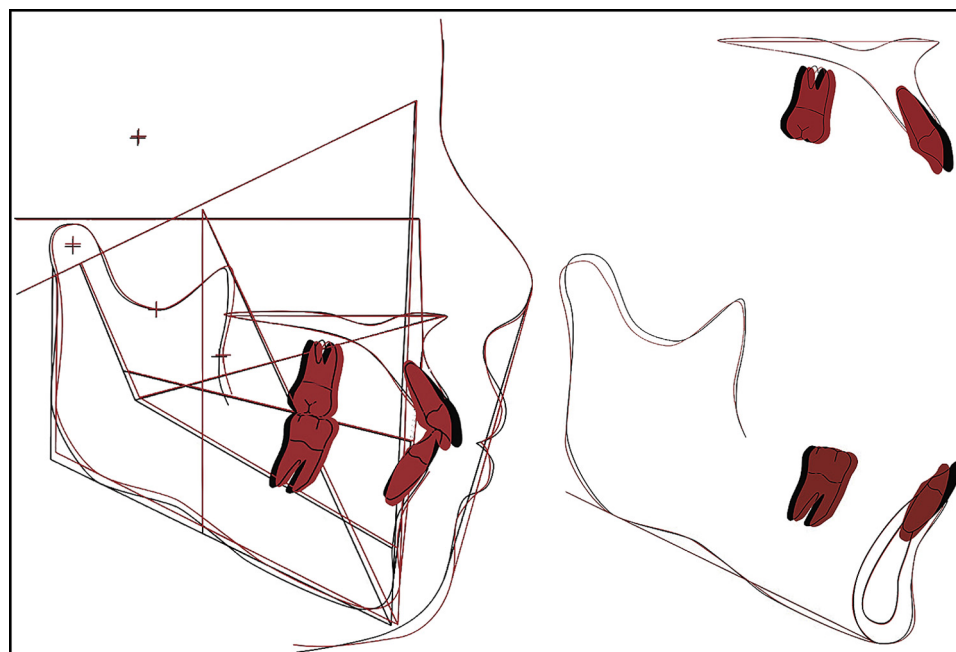


Fig 9. Cephalometric superimposition. *Black*, Pretreatment; *red*, posttreatment.

fractures or when there is a loss of ramus height. Many authors have suggested that in cases without occlusal deviation or other symptoms (such as pain), no immobilization is required, and active physiotherapy with close follow-up is sufficient.^{3,14} Most surgeons favor nonsurgical treatment of condylar fractures because it produces satisfactory results in most patients without increasing the risk of morbidities from surgery.¹³ Since our patient was asymptomatic and showed only a slight deviation upon opening, conservative therapy was indicated as the treatment of choice. According to the referenced literature, condylar regeneration and remodeling with adaptive changes will lead to functional restoration of the TMJ.^{4,20-23} After a discussion with the patient's oral surgeon, we decided to observe the remodeling of the fractured right condyle during her comprehensive orthodontic treatment. The treatment comprised full fixed appliances along with 2 maxillary first premolar and 2 mandibular second premolar extractions to relieve her severe crowding, with maximum anchorage using a temporary skeletal anchorage device (TSAD) to improve both her occlusal function and esthetics.

Even though the molars were in a Class I relationship, in this patient, the mandibular second premolars were the extraction of choice because the mandibular left second premolar was smaller than the first premolar and was rotated. The mandibular right second premolar was also

severely displaced lingually. In addition, we used a tip-edge system, which could create strong anchorage of the posterior segment and produce excessive lingual movement of the incisors. Based on these factors, the mandibular second premolars were selected for extraction.

TREATMENT PROGRESS

Before orthodontic treatment, the patient was referred to a general dentist to verify that there were no cavities and for extraction of the maxillary first premolars and mandibular second premolars. Full fixed 0.022-in tip-edge appliances (TP Orthodontics, LaPorte, Ind) were placed and bonded on both arches for leveling and alignment. To relieve the severe crowding, a TSAD (diameter, 1.6 mm; length, 8.0 mm; OSAS, Tuttlingen, Germany) was placed on the paramedian palatal area and connected to the transpalatal arch that was soldered to the maxillary second molar bands. The mandibular extraction spaces were closed with elastomeric chains from the second molars to circles between the canines and the first premolars on the 0.022-in Australian wire. The minor extraction spaces in the maxillary arch were closed with elastomeric chains from the second molars to circles between the lateral incisors and the canines on the 0.022-in Australian wire.

During the finishing stage, final detailing of the occlusion was accomplished with 0.017 × 0.025-in stainless steel archwires in conjunction with short anterior



Fig 10. Thirty-month posttreatment facial and intraoral photographs.

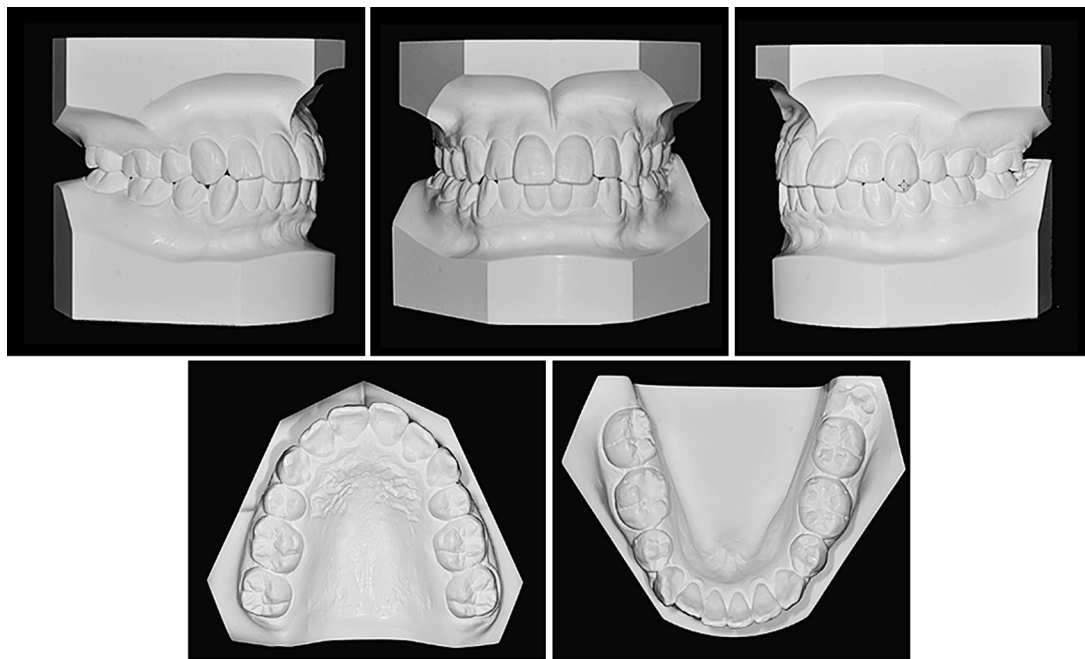


Fig 11. Thirty-month posttreatment dental casts.

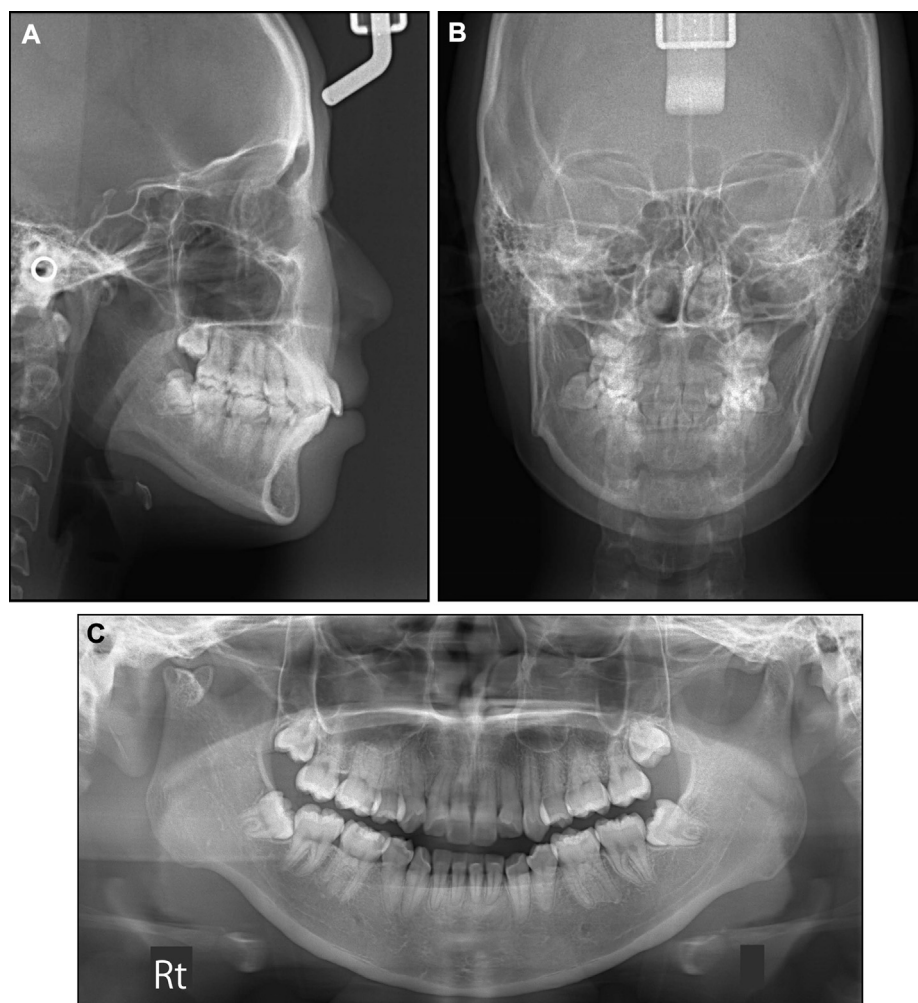


Fig 12. Thirty-month posttreatment radiographs: **A**, lateral cephalogram; **B**, posteroanterior cephalogram; **C**, panoramic radiograph.

triangular up-and-down elastics from the maxillary canines to the mandibular canines and premolars worn at night. At the finishing stage, interproximal reduction was recommended to improve the dental midline and the Bolton discrepancy. However, the patient and her mother declined the procedure, leaving her dental midline deviated (Fig 5). Fixed retainers were attached to the maxillary and mandibular anterior teeth. Wrap-around removable retainers were also delivered to secure the stability of both arches. Total treatment time for this patient was 21 months.

TREATMENT RESULTS

The posttreatment records showed that the treatment objectives were achieved. The facial photographs showed improved smile esthetics. The severe crowding in both arches was relieved, acceptable overbite and overjet were achieved, and her dental midlines were

improved. A Class I molar relationship was maintained, and the canine relationship was improved with canine-protected occlusion. She did not report any temporomandibular disorder symptoms during her orthodontic treatment (Figs 6 and 7).

The posttreatment panoramic radiograph showed proper space closure and acceptable root parallelism except for the mandibular right canine and first premolar, and there were no significant signs of bone or root resorption. The posttreatment lateral cephalometric analysis and superimposition showed slight skeletal changes (ANB, 3.5°) with no significant changes in the mandibular plane angle (SN-MP, 34.1°). The maxillary and mandibular incisor proclinations (U1 to SN, 107.4°; IMPA, 93.4°) were improved (Figs 8 and 9; Table). The patient's facial profile, especially the protrusion of her lips, was improved (Figs 6 and 9).

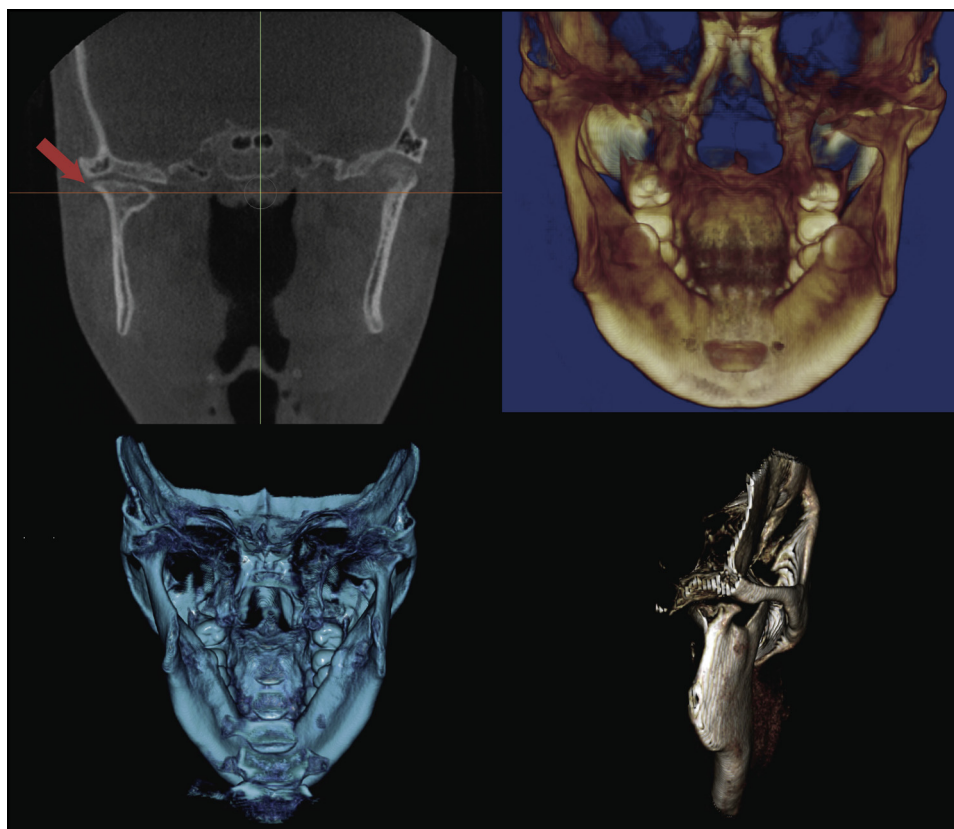


Fig 13. Thirty-month posttreatment CBCT scan showing remodeling of the fractured mandibular right condyle.

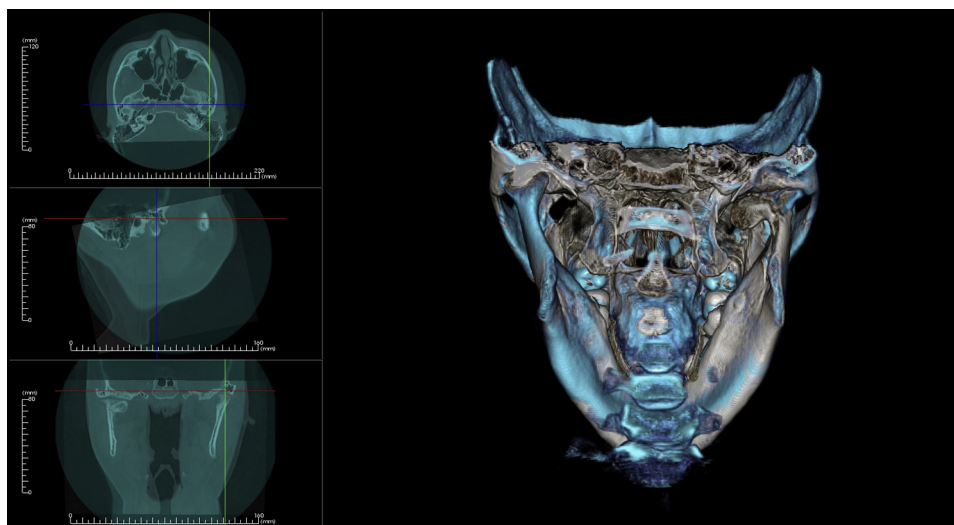


Fig 14. Superimposed 3-dimensional CBCT images showing remodeling of the fractured mandibular right condyle.

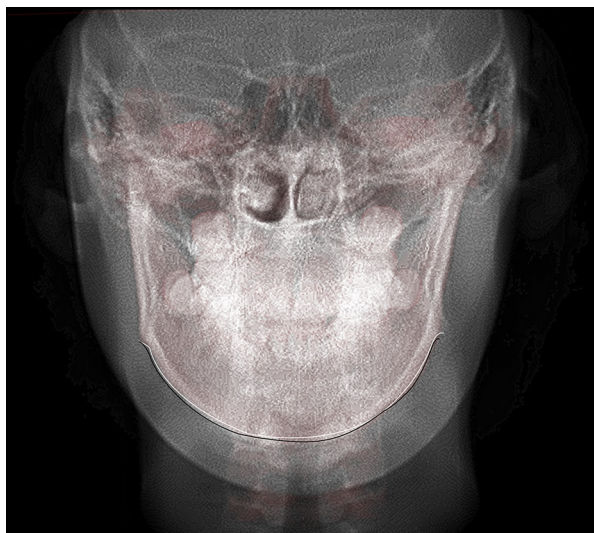


Fig 15. Superimposed 3-dimensional CBCT images showing a slight mandibular deviation. *White line*, Pretreatment; *black line*, 30 months posttreatment.

At the 30-month retention examination, the records showed some relapse on her right lateral incisor and canines (Figs 10 and 11). The root parallelism between the mandibular right canine and first premolar was improved. The patient was referred to her oral surgeon for an evaluation of the extraction of her third molars (Fig 12). The 30-month retention CBCT images were superimposed with the pretreatment images.²⁴⁻²⁸ They showed bone remodeling on the fractured condyle area (Figs 13 and 14). Although it was not noticeable clinically, her CBCT superimposition showed mandibular deviation (Fig 15).

DISCUSSION

A unilateral condylar fracture is common with deviation to the affected side during mouth opening and limited lateral excursion on the unaffected side.⁵ Because the lateral pterygoid and temporomandibular ligaments insert into the mandibular condyle, damaged lateral pterygoid muscle and temporomandibular ligament could produce these effects as a result of the condyle fracture on the affected side. Ellis and Throckmorton¹³ stated that the action of the lateral pterygoid muscle may no longer exert its action on the distal portion of the mandible, resulting in deviation toward the affected side upon mouth opening. As they suggested, our patient had a deviation toward the affected side, which was reduced after the orthodontic treatment combined with physiotherapy (open-close movements).¹⁵

Generally, mandibular condylar fractures have been treated with open reduction (surgical intervention to repose and stabilize the fragments) or closed reduction (intermaxillary immobilization followed by functional therapy),^{6,12,29,30} even though a conservative approach is generally preferred in children, and open reduction and internal fixation are preferred in patients older than 14 years old.^{6,8} After reviewing 466 condyle fracture cases, Zachariades et al¹⁴ also recommended that intracapsular fractures in pediatric patients can be treated with a conservative approach with or without maxillary-mandibular fixation, and they can be treated with limited open reduction to restore the occlusion in severely displaced and dislocated fractures in those with a loss of ramus height and in edentulous patients. Although surgical treatment of the fractured segments has been advocated to prevent deteriorating complications such as open bite, reduced excursive mobility, and deviation on opening and retrognathia,^{31,32} it can also expose patients to facial nerve and blood supply damage, infection, and necrosis, which can be prevented with more conservative treatments.¹³ Because our patient was asymptomatic with no swelling or pain and had only a mild deviation upon opening, she was treated with a conservative approach, considering the above-mentioned treatment selection criteria. During her orthodontic treatment, she had no TMJ symptoms, which shows the absence of late complications secondary to TMJ trauma.

Skeletally derived anchorage systems, such as TSADs, have allowed for treatment options that produce the desired results without undesirable side effects. This method allows clinicians to retract anterior teeth without anchorage loss on the posterior teeth. Although palatal bone thickness might be adequate for adults, there might be some doubt about applying TSADs on the palate of young patients.³³⁻³⁵ Recently, palatal bone thickness and density were assessed in children and adolescents, and found to be suitable for placement of TSADs.^{36,37} In addition, palatal soft tissue thickness has been evaluated using an ultrasonic device and CBCT images to find the most appropriate placement locations for TSADs.³⁸ The palatal approach for TSADs has several advantages over buccally placed TSADs; when interdental spaces are small, buccally placed miniscrews can increase the risk of root contacts. In this study, we used indirect anchorage, and a miniscrew was placed in the paramedian region of the palate to prevent root contact.

Condylar remodeling has been frequently seen as a result of fracture healing in nonsurgical treatments.^{4,20-23} Strobl et al⁵ reported a clinical success

rate of 100% with isolated unilateral condyle fractures, consistent with the long-term findings of other authors who reported that condylar remodeling and regeneration with adaptive changes lead to functional restoration of the TMJ. In their study, radiographic follow-up evaluations showed signs of bone remodeling in each patient 6 weeks after the trauma. At 48 weeks (1 year) after the trauma, remodeling was complete in all patients, with adaptive changes on the articular surface of the condyle seen in those where fracture healing occurred without adequate alignment at the fracture site. No further remodeling was noticed during follow-up later in the patients' growth period.⁵ Medina¹⁵ suggested a treatment-monitoring protocol of clinical evaluations every month and panoramic radiographs every 6 months for the first 2 years and then yearly thereafter. She also stated that at the 6-month evaluation, normalization of mandibular movement was observed. In our patient, the 30-month retention CBCT images showed bone remodeling on the fractured condyle area, and her mandible had normal movement.

Condylar remodeling and regeneration can produce morphologic changes to the condyle itself. Our patient showed a bifid condyle on the side of the condylar fracture after the conservative treatment. A bifid condyle is a rare anatomic variation of a mandibular condyle, and no definite etiologic factor has been identified. It is suggested that a bifid condyle could be a developmental anomaly or secondary to trauma.³⁹ In most cases, patients have no symptoms, and the majority of bifid condyles are detected during a routine radiographic examination, as in our patient.^{39,40}

CONCLUSIONS

In this case report, a unilateral condylar fracture and severe crowding on both arches were treated with orthodontics and a TSAD after extraction of 4 first premolars. After orthodontic treatment, the patient's general esthetics and function were significantly enhanced, and the fractured condylar area showed remodeling during the retention stage.

ACKNOWLEDGMENTS

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